

scattering and absorption coefficients for leaf material in the inverse mode and predicts reflectances and transmittances similar to laboratory values in the forward mode.

A canopy model was developed and linked with LEAFMOD, and LEAFMOD was modified so that it would compute leaf absorbance properties given the concentration of the main chemicals in the leaf (water, chlorophyll, protein, cellulose, and lignin). The linked models were used to simulate hypotheti-

cal trends in plant canopy reflectances resulting from such factors as leaf dry-out and chlorosis (chlorophyll depletion). Barry D. Ganapol, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, collaborated with the Ames investigators on this project.

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Amazon Ecology from Space

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The degree to which primary production, soil carbon, and trace-gas fluxes in tropical forests of the Amazon are limited by moisture availability and other environmental factors has been examined using a new ecosystem modeling application for Brazil. A regional geographic information system serves as the data source of climate drivers, satellite "greenness" images, land cover, and soil properties for input to the NASA-CASA model over an 8-kilometer-grid resolution. This study describes the first published use of satellite remote sensing to simulate regional carbon and nitrogen fluxes and associated "greenhouse" gas emissions in the rain forests and savannas of Brazil.

Major findings of this modeling research include the following. Simulation results imply that net primary production (NPP) is limited by cloud interception of solar radiation over the humid northwestern portion of the region, with peak annual rates for NPP of nearly 1.4 kilograms of carbon per square meter per year localized in the seasonally dry eastern Amazon in areas that we assume are primarily deep-rooted evergreen forest cover. Regional effects of the conversion of Amazon forest to pasture on NPP and soil carbon content are indicated in the model results, especially in seasonally dry areas (see figure). Pasture plants and annual crops planted in areas of cleared Amazon rain forest are less tolerant of drought and less capable of tapping deep soil moisture supplies than the forest tree species that they replace. Comparison of model flux predictions

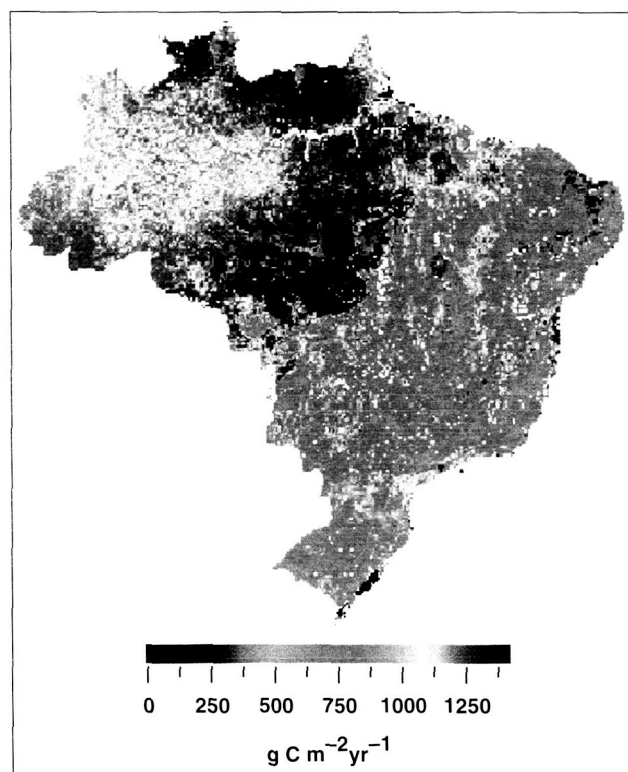


Fig. 1. Net primary production estimated at 8-kilometer cell resolution by the NASA-CASA model for Brazil, ca. 1990.

along selected ecoclimatic transects reveal moisture, soil, and land-use controls on gradients of ecosystem production and soil trace-gas emissions (carbon dioxide (CO_2), nitrogen dioxide (N_2O), and nitric oxide (NO)).

Building upon this research, ecosystem scientists at Ames Research Center have been selected for the

NASA Science Team component of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia.

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Ultraviolet Radiation Effects on Carbon Isotope Fractionation

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The objective of this project is to determine if ultraviolet (UV) radiation affects stable carbon isotope ratios. If so, is there an ecologic (e.g., microbial mat vs. phytoplankton) or taxonomic (e.g., prokaryote vs. eukaryote, alga vs. plant) correlation with the effect? These data will provide the basis for presenting the phenomenon to the scientific community, for estimating how widespread the phenomenon is, and for suggesting ways to begin to elucidate the mechanisms underlying the effect. Ultimately this work could lead to a re-interpretation of isotopic ratio studies, including a re-interpretation of the fossil record.

Isotopic measurements and, more specifically, ratios of ^{13}C to ^{12}C (isotopes of carbon) in organic relative to inorganic matter, play an important role in interpreting biological activity. In the interpretation of the fossil record, stable carbon isotope ratios are one of the most critical sources of data next to morphological fossils. They are a possible approach to searching for life on Mars. Stable carbon isotope ratios are playing an increasingly important role in the analysis of global carbon fluxes, of biogeochemical features of modern ecosystems, and of community structure. They have even been used to determine diet in archeological studies.

The stable carbon isotopic composition ($\delta^{13}\text{C}$) of a plant or photosynthetic microorganism growing on carbon dioxide (CO_2) is determined principally by the isotopic composition of the CO_2 as well as by any isotopic discrimination associated with CO_2 uptake. Bulk isotopic composition can be further modified somewhat by enzymatic discrimination during the biosynthesis of amino acids, lipids, and nucleotides, and during respiration. To the extent that

UV irradiation alters the patterns of carbon flow in an organism, it can also alter isotopic composition.

An experiment was conducted to determine if UV could affect stable carbon isotope ratios in algal communities. Screens were set up that were UV-transparent or that filtered out UVA or UVA+UVB, over two types of microbial ecosystems in Yellowstone National Park; one dominated by the red alga *Cyanidium* sp., and one dominated by the green alga *Zygogonium* sp. After 90 days of the treatments, the samples were collected, frozen, and turned over to DesMarais' laboratory for analysis. The results (first figure) are clear: In these two mats, UV radiation does affect the carbon isotopic signature.

Experiments were then conducted on radishes to examine UV effects on isotope fractionation. Radish seeds were grown in flats on the roof of the laboratory under different types of UV screening, with approximately 50 plants germinating per treatment. The plants were rotated periodically and were grown

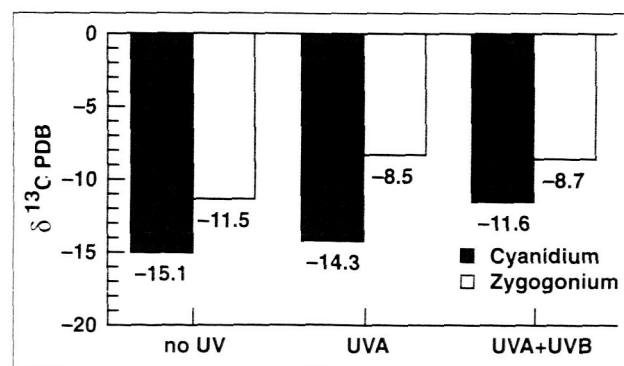


Fig. 1. Carbon isotope values for red and green algae grown under three different UV treatments.